RB 50-15

POWER SUPPLIES UNLIMITED

NJE CORPORATION KENILWORTH, NEW JERSEY

A SUBSIDIARY OF CONDEC CORPORATION

INSTRUCTION MANUAL

RB LINE
RB 50-15-1

HALF -RACK BENCH TYPE SERIES REGULATED

CONSTANT VOLTAGE - CONSTANT CURRENT

SERIAL NUMBER 31982-20

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WARNING

THIS EQUIPMENT EMPLOYS VOLTAGES WHICH ARE DANGEROUS AND CAN BE FATAL IF CONTACTED BY OPERATING PERSONNEL. EXTREME CAUTION MUST BE EXERCISED WHEN WORKING WITH THIS EQUIPMENT.

INTRODUCTION

DEVIATIONS:

This manual covers the Standard NJE Power Supplies as indicated in Section I herein. Where deviations to the specifications are built into equipment at the customer's request, the nature of the deviation as it affects this manual is indicated in a Specification Sheet which precedes Section I. If special Schematic Diagrams, Parts Placement Drawings and/or Spare Parts List(s) are required for the deviation, they will be found in Section V of the manual, in place of, or along with the Standard material.

CORRESPONDENCE:

All correspondence must reference the complete description of the unit as shown on the identification label located at the rear of the power supply.

In requesting Spare Parts or information relative to parts, the Reference Designation, the rating, the description, and the NJE Part Number must be specified for each part in question.

DESIGN IMPROVEMENTS:

NJE Corporation reserves the right to make design improvements on any instrument without prior notice.

REPRODUCTION:

No written material, drawings, text figures, or any part of this Instruction Manual may be reproduced without express written consent of NJE Corporation.

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Rev. A.: 6/19/67

REPAIR SERVICE

NJE Corporation provides complete repair facilities at the main plant and at local service centers as listed in the rear of the manual. These repair facilities are adequately staffed with factory trained technicians to assure our customers of the most knowledgeable and expedient servicing of our equipment. All equipment forwarded to these facilities must be adequately packaged to prevent damage in transit.

OUT OF WARRANTY SERVICE:

Forward defective equipment to factory or local service center prepaid. A full description of difficulties encountered or the repair required should accompany this shipment. An estimate of the cost of repair will be submitted to you. The necessary servicing will be performed only upon receipt of your written service orders. Your equipment will be returned to you via collect shipment unless otherwise specified on your service order.

IN WARRANTY SERVICE:

If, during the warranty period the power supply indicates an inherent defect, immediately communicate with your nearest NJE Field Representative in your area. If, after examination, he concurs that the unit is defective under the warranty conditions, he will provide written authorization for the return of the unit to the factory or the local field service center, whichever is nearer. NJE Corporation will not assume any transportation charges on incoming equipment without the concurring written approval from its field representative.

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Rev. A.: 6/19/67

SECTION 1

SPECIFICATIONS

1.1 GENERAL:

The RB line of Half-Rack or Bench Type Series Regulated Power Supplies is designed to use in applications requiring a well regulated stable source of DC power, and where close regulation of the output voltage and output current is required. The specifications herein are tabulated (See Table 1-1) where ratings change from unit to unit or from Constant Voltage Mode to Constant Current Mode of operation. The specifications are generalized into paragraphs where rating are common.

1.2 GENERAL ELECTRICAL SPECIFICATIONS:

1.2.1 Input: 105 to 125 Volts, 55 to 65 cps, single phase at approximately 2 amperes.

1.2.2 Output Voltage and Current: See Table 1-1.

1.2.3 Static Regulation:

1.2.3.1 Load: At constant input voltage, the regulation is less than the figure indicated in Table 1-1 for a load change from half load to full load, and less than the figure indicated in Table 1-1 for a load change from half load to no load.

1.2.3.2 Line: At constant load, the regulation is less than the figure indicated in Table 1-1 for a line change from 115V to 105V, and less than the figure indicated in Table 1-1 for a line change from 115V to 125V.

1.2.4 Ripple:

1.2.4.1 Constant Voltage Mode: 250 microvolts RMS or 2 millivolts peak to peak, maximum.

1.2.4.2 Constant Current Mode: 3 millivolts, peak to peak, maximum, at output terminals.

1.2.5 Transient Response: For a ±10 Volt step change in line voltage, the output voltage will remain in the regulated region. For a no load to full load or a full load to no load step change, the output voltage will return to within 10 millivolts of the regulated region in less than 50 microseconds.

1.2.6 Meters: A single meter with switch for selection of voltage or current reading rated accurate to 2% of full scale value is provided on the front panel.

1.2.7 Polarity: The output may be "floated" up to 500V peak above ground. Either polarity may be grounded to chassis by means of terminals provided.

1.2.8 Duty: Continuous at ambient temperatures from 0° C to 45° C. Operation above 45° C is allowed provided the output current is derated linearly to zero at 80° C.

1.2.9 Remote Sensing: (For Constant Voltage Mode only) Sensing terminals, separate from the output terminals, provide sensing and load regulation against the voltage at the load rather than the voltage at the power supply output terminals. This eliminates the otherwise unavoidable load regulation due to the voltage drop in the wires connecting the supply to the load. This feature does not eliminate voltage excursions resulting from load transients through load line impedance.

1.2.10 Remote Programming: The output voltage may be controlled accurately from a remote point if desired, by varying the resistance across the REMOTE PROGRAM terminals. The sensitivity of this circuit is approximately 140 ohms per volt above the minimum voltage within the voltage limits of Table 1-1.

1.2.11 Dualling: Two or more units may be operated in series to provide higher voltage output at rated current. Like units may be operated in parallel provided that the total current drawn is derated by 10%. All dual unit installations must meet the cooling requirements of paragraph 1.3.2.

1.2.12 Termination: A barrier type terminal strip at the rear of the unit provides interface connection for input, output, remote sensing, remote programming and ground. Front panel binding posts for output termination and ground in addition to the output terminals at the rear are provided.

1.2.13 Protection: Overload protection is provided by the mode of operation as discussed in Paragraph 1.2.15 below. Protective fuse will interrupt input power in the event of component failure.

1.2.14 Output Capacitor: The output capacitor is permanently connected to the output terminals.

1.2.15 Mode of Operation: Constant current and constant voltage levels may be preset within the maximum rated voltage and current levels specified in Table 1-1. Referring to the graph of Figure 1-1, the intersection of the constant voltage and constant current operation lines, called the "Crossover Point", may be located anywhere within the output voltampere range of the unit. Regardless of the demands of the load, the output voltage and/or the output current will never exceed the limits preset by the output voltage and output current controls.

1.2.16 Resolution:

1.2.16.1 Output Adjust: Continuously variable coarse and vernier OUTPUT ADJUST potentiometers on concentric shafts provide the resolution indicated in Table 1-1.

1.2.16.2 Current Control: Continuously variable single turn potentiometer provides the resolution indicated in Table 1-1.

1.3 MECHANICAL SPECIFICATIONS:

1.3.1 Outline Drawing: Table 1-1 indicates which Outline Drawing is applicable to the unit in question.

1.3.2 Airflow: All units have internal blowers and depend on forced air cooling in addition to conduction and convection cooling. Air flow paths as indicated in the appropriate Outline Drawing must not be blocked.

1.3.3 Mounting: Unit is designed for bench mounting. Rack adapters are available as follows:

1.3.3.1 NJE Model RP1, adapter to mount one unit centered on a standard 19" rack panel 5-1/4" high: order NJE Part No. 080539.

1.3.3.2 NJE Model RP1A, adapter to mount one unit offset to the left on a standard 19" rack panel 5-1/4" high: order NJE Part No. 081855.

1.3.3.3 NJE Model RP2, adapter to mount any two units on a standard 19" rack panel 5-1/4" high: order NJE Part No. 080537.

1.3.4 Finish: Exterior finished in dark grey enamel equivalent to FED STD 595 chip #26132. Panel marking is white. All other finishes are appropriate paint, plating or chemical film as required.

1.4 OPTIONAL FEATURES:

The specific optional features which are available on any given unit and the general description of these optional features follows:

1.4.1 Suffix (-P): Addition of three wire power cord and plug.

1.4.2 Suffix (-SF): Non-standard finish to exterior of unit.

1.4.2.1 Where specifying (-SF) option customer must provide NJE the following information:

Color to be used (preferably FED STD 595 chip number).

Color to be used for marking.

Process to be used if other than NJE Standard finish process.

Whether paint is to be supplied by customer or NJE.

1.4.3 Suffix (-LV) and/or (-LC): Output Adjust (-LV) or Current Control (-LC) potentiometer and knob replaced by a single turn screwdriver adjust potentiometer with shaftlock. (-LV) option changes Output Adjust resolution to 1%.

1.4.4 Suffix (-TT): Replacement of standard Output Adjust potentiometer by a ten-turn continuously variable potentiometer with a decade dial and lock, providing an improved resolution of 0.02%.

1.4.5 See paragraph 1.3.3 for rack adapters.

NOTE: Example of buildup of final model number for RB36-2-M with line cord is as follows: RB 36-2-M-P.

NOTE: NJE Corporation invites requests for quotations on special requirements which can be accomplished by deviations of standard catalogue units.

MODEL NO.	OPERATION MODE	OUTPUT		STATIC REGULATION (1)		WEIGHT		OUTLINE DWG.	RESOLUTION
		VOLTS	AMPS	LOAD	LINE	NET	SHIP		
RB-18-3-M	CONSTANT VOLTAGE	0-18	0-3	0.01% OR 1.0MV	0.01% OR 1.0MV	18 LBS.	28 LBS.	303346	10MV
	CONSTANT CURRENT			2MA/V (2) CHANGE IN OUTPUT	0.5MA			303353	30MA
RB-36-2-M	CONSTANT VOLTAGE	0-36	0-2	0.01% OR 1.0MV	0.01% OR 1.0MV	18 LBS.	28 LBS.	303346	20MV
	CONSTANT CURRENT			1MA/V (2) CHANGE IN OUTPUT	0.5MA			303353	20MA
RB-50-1.5-M	CONSTANT VOLTAGE	0-50	0-1.5	0.01% OR 1.0MV	0.01% OR 1.0MV	18 LBS.	28 LBS	303346	25MV
	CONSTANT CURRENT			0.75MA/V (2) CHANGE IN OUTPUT	0.5MA			303353	15MA

(1) WHICHEVER IS GREATER
(2) TAKEN OVER THE ENTIRE VOLTAGE RANGE

TABLE 1-1

TABULATED SPECIFICATIONS

TYPICAL OPERATION CURVES

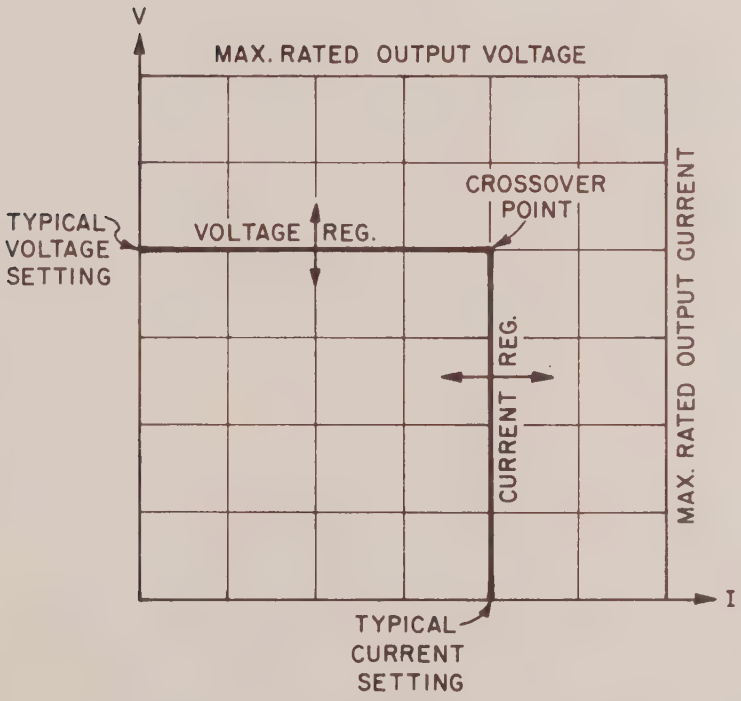
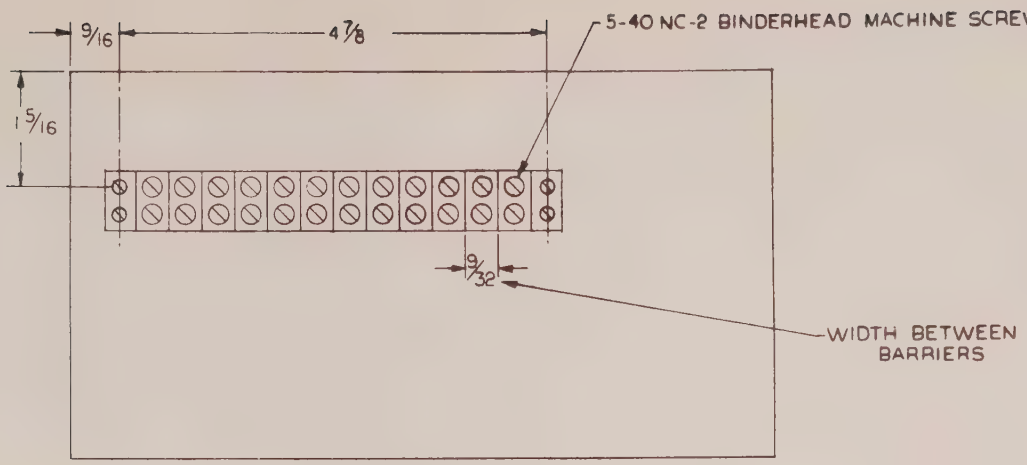
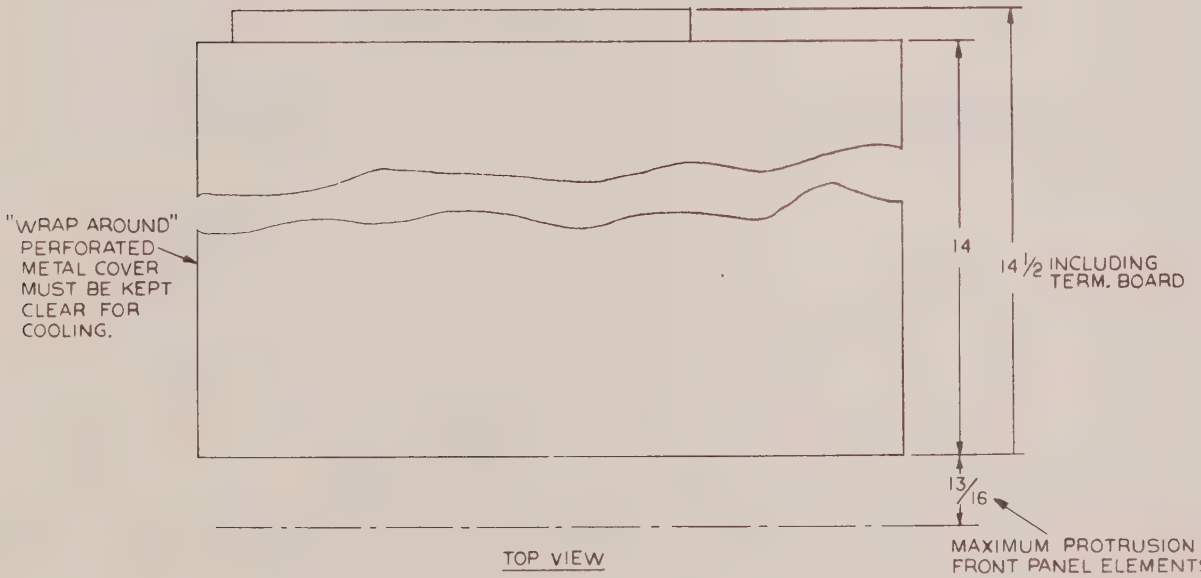


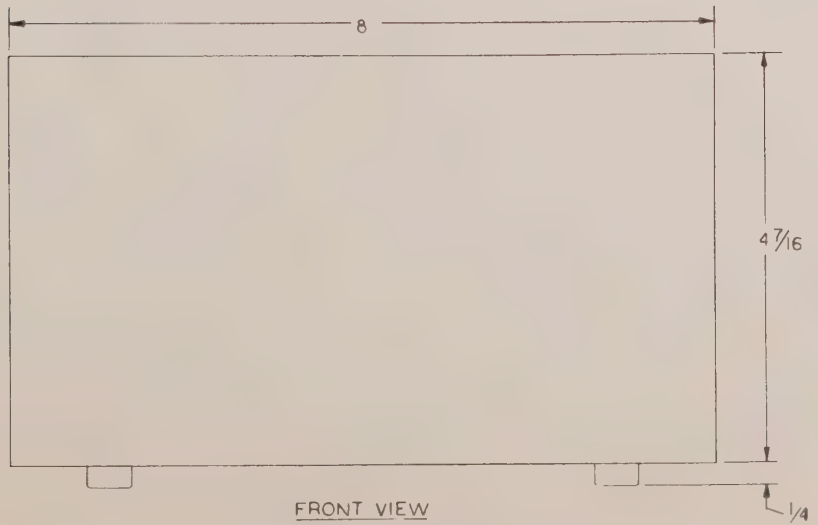
FIG. 1-1



REAR VIEW


"WRAP AROUND" PERFORATED METAL COVER MUST BE KEPT CLEAR FOR COOLING.
14
14 1/2 INCLUDING TERM. BOARD
13/16
MAXIMUM PROTRUSION OF FRONT PANEL ELEMENTS

TOP VIEW



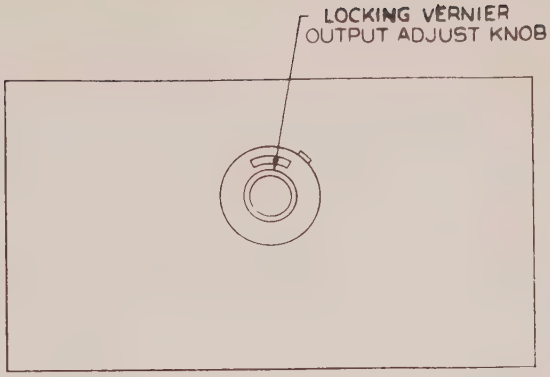
FRONT VIEW

NOTE:
1 ALL TOLERANCES ± 1/32 UNLESS OTHERWISE SPECIFIED

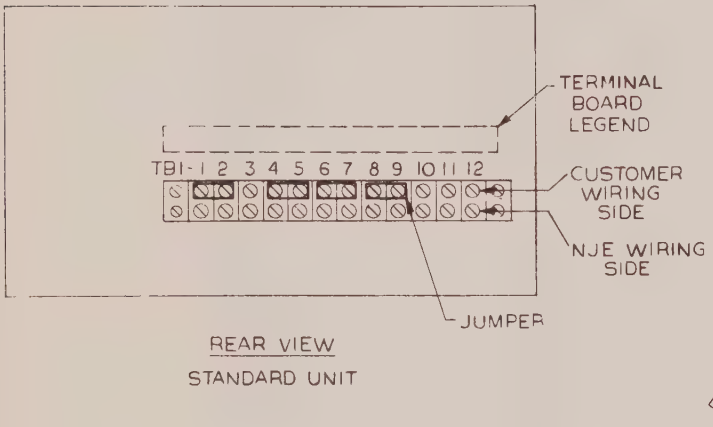
OUTLINE DRAWING
HALF RACK SUPPLIES

TBI TERMINAL BOARD LEGEND				
TERM NO	SCREENED FUNCTION	RECOM'D WIRE SIZE	REMARKS	
1	POS SEN	NO. 20 AWG	NORMALLY JUMPED TO POS OUT	1
2	POS OUT	NO. 20 AWG		
3	GRD	NO. 20 AWG	DC GROUND	
4	NEG OUT	NO. 20 AWG		
5	NEG SEN	NO. 20 AWG	NORMALLY JUMPED TO NEG OUT	1
6 7	REMOTE PROGRAM	NO. 20 AWG	NORMALLY JUMPED TOGETHER	1
8 9	DUALLING	NO. 20 AWG	NORMALLY JUMPED TOGETHER	2
10	AC	NO. 20 AWG	HIGH SIDE OF AC INPUT	
11	GRD	NO. 20 AWG	AC GROUND	
12	AC	NO. 20 AWG	RETURN SIDE OF AC INPUT	

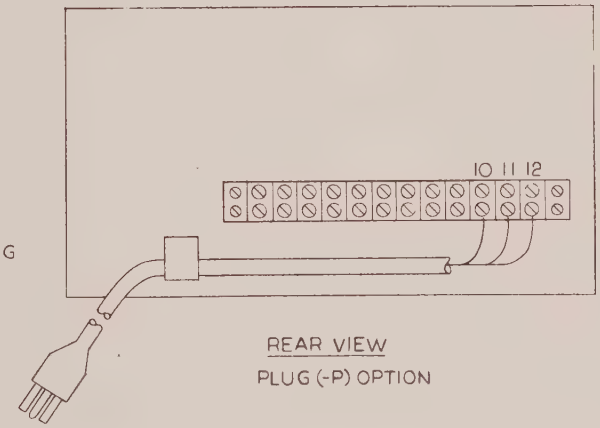
1. TWISTED PAIR WHERE USED.
2. TERMINAL NO.8 IS DUALLING DRIVE POINT.



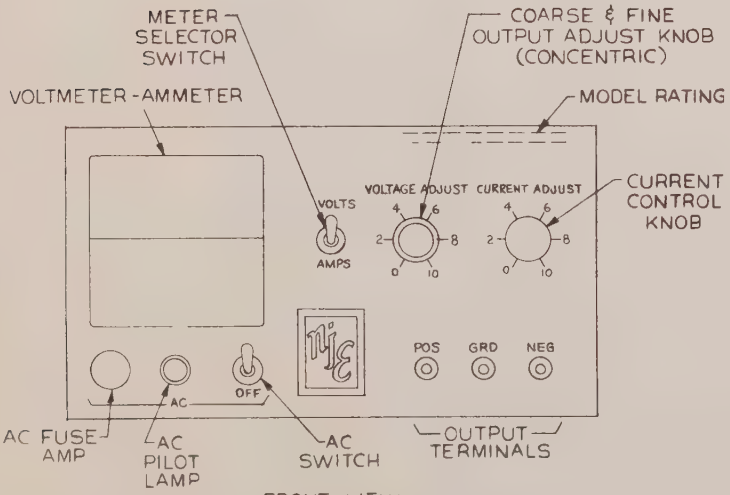
FRONT VIEW
OPTION (-TT)



REAR VIEW
STANDARD UNIT



REAR VIEW
PLUG (-P) OPTION



FRONT VIEW
FRONT PANEL ELEMENTS, STANDARD

RB LINE

303353

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SECTION II

INSTALLATION AND OPERATION

2.1 UNPACKING: The power supply is shipped in a corrugated carton which is floated on sufficient insulation in a heavy-duty shipping carton. Aside from normal precaution against damage to the unit in opening the cartons and removing the unit, no special procedures are required. The carton should be opened immediately upon receipt and the contents inspected for shipping damage. The power supply was checked electrically and mechanically before it left the factory, and is warranted to be in perfect operating condition. This warranty does not cover possible damage incurred during shipment. Therefore, any evidence of mishandling, such as broken, deformed or missing parts, should be brought to the attention of the transportation company, and a claim should be entered. Remove top cover plate and inspect all components and wiring, both on the chassis panel, as well as the mechanical condition of the housing. The literature packed with the supply should be removed and held for reference in operating the equipment.

2.2 INSTALLATION: Refer to Table 1-1 which indicates which Outline Drawing is to be followed for the model in question. This Outline Drawing shows mounting dimensions, air flow requirements, interface wiring information and other data pertinent to proper installation. Careful observance of all the specification requirements in Section I is essential to a proper installation. READ THE SPECIFICATIONS CAREFULLY BEFORE PROCEEDING.

When the unit has been properly placed in position or mounted in its rack and secured in place by the panel screws, electrical connections should be made in accordance with the following step-by-step procedure. Wire sizes to be used and the terminal locations are specified on the appropriate Outline Drawing of Section 1-3. Terminal functions listed in the following instructions are clearly screened on the equipment itself, as well as being indicated on both the outline of Section 1-3 and the Schematic Diagram of Section V.

2.3 STANDARD SINGLE UNIT ELECTRICAL INSTALLATION:

2.3.1 Output Grounding: Connect either the positive (POS OUT) or negative (NEG OUT) DC output terminal of the supply (depending upon desired output polarity) directly to the chassis ground terminal (GRD) at the barrier strip on the rear of the chassis, and connect the ground terminal to the system ground.

NOTE: If it is necessary that the power supply circuit float above or below ground, it is recommended that the output terminal should be connected to the chassis ground terminal by a 0.1 microfarad 600 VDC capacitor in place of the direct connection. Use of this by-pass capacitor will improve the stability of the circuit in the ungrounded condition, and reduce the effect of external interference and hum. Refer to Polarity Specification in Section I for maximum limitation on floating voltage permitted.

2.3.2 Output Connection: Connect the positive and negative output terminals (POS OUT) and (NEG OUT), respectively to the corresponding terminals of the external load. Use heavier gauge wire than that specified if long distances to the load are involved.

2.3.3 Remote Sensing: All units are shipped from the factory with the REMOTE SENSING feature jumpered out on the inter-connection terminal board as follows: (POS SENS) connected to (POS OUT) and (NEG SENS) connected to (NEG OUT). With this connection, the regulation specifications are met ONLY at the output terminals of the supply. If it is desired to have accurate regulation at the remote load point, rather than at the output terminals, proceed as follows:

Connect the output terminals to the load per Paragraph 2.3.2 above. Remove the Jumpers from (POS SENS) to (POS OUT) and (NEG SENS) to (NEG OUT) respectively. Observing correct polarity, run a twisted pair of No. 20 AWG wire (or larger) from (POS SENS) to the positive load point and from (NEG SENS) to the negative load point.

WARNING: DO NOT OPERATE POWER SUPPLY WITHOUT THE SENSING LEADS CONNECTED EITHER REMOTELY OR LOCALLY. MOST CUSTOMER COMPLAINTS OF POOR OPERATION ARE DUE TO IMPROPER SENSING LEAD CONNECTION.

WHEN THE POINT OF REMOTE SENSING IS MORE THAN 10 FEET FROM THE POWER SUPPLY, OSCILLATIONS MAY DEVELOP. A POSSIBLE CURE IS TO CONNECT REMOTE CAPACITANCE AS DESCRIBED IN PARAGRAPH 2.3.4 AND AS CLOSE TO THE POINT OF SENSING AS IS PHYSICALLY POSSIBLE.

2.3.4 Output Capacitor Connections: This feature is not provided on all units. When included in the equipment, the terminals are listed as (POS CAP) and (NEG CAP) on the Outline Drawing. The power supply has been shipped from the factory with the appropriate filter capacitors connected to the appropriate output terminals at the interconnection terminal board. This arrangement is satisfactory for most applications. However, if better transient and dynamic characteristics are required, further improvement can be effected by using an independent capacitor mounted as close to the ultimate load as is practical.

The capacitor used should have the same voltage rating of the power supply output capacitance (see the Schematic Diagram for the rating of the capacitor connected to the Pos Cap and Neg Cap terminals) and at least the same capacitance rating should be used. Additional capacitors may be ordered by specifying the NJE Part Number of the output capacitor from the Spare Parts List of Section V.

Reconnections are made as follows: Remove the jumper connection provided between (Pos Out) and (Pos Cap) and between (Neg Out) and (Neg Cap). The load leads should be connected as in Paragraph 2.3.2 above. Connect the new capacitor directly at the load being careful to observe polarity. In order to make this connection effective, it will be necessary to utilize the Remote Sensing Connections described in Paragraph 2.3.3 above.

2.3.5 Remote Programming:

To utilize either the Remote Voltage Program or Remote Current Program when specified per Section I, remove jumper across the appropriate terminals and connect a resistor across the Remote Program terminals. If the resistor is to be located remotely from the power supply, a twisted pair of No. 20 AWG should be used. The resistance (R) of the remote program resistor may be calculated as follows:

2.3.5.1 Remote Voltage Program

$R \ (\Omega/V) \ (V_o - V \text{ min})$ ohms

Where (R) is the desired resistance, (Ω/V) is the Remote Programming Sensitivity from Section I. (V_o) is the desired output voltage and (V min) is the minimum voltage allowed for the power supply as specified in Section I.

The VOLTAGE ADJUST potentiometers should be set to zero (extreme counter clockwise) when this connection is used.

2.3.5.2 Remote Current Program (where specified in Section I).

$R \quad (\Omega/I)\ (I_O - I \text{ min})$ ohms

Where (R) is the desired resistance, (Ω/I) is the Remote Programming Sensitivity from Section I. (I_O) is the desired output current and (I min) is the minimum current.

The CURRENT ADJUST potentiometers should be set to zero (extreme counter clockwise) when this connection is used.

WARNING: DO NOT OPERATE THE POWER SUPPLY WITH EITHER "REMOTE PROGRAM" TERMINAL OPEN CIRCUITED.

2.3.6 Input Connection:

2.3.6.1 For those units supplied without three wire line cord and plug, refer to the applicable Outline Drawing in Table 1-1. Connect the proper wire size specified to the two (2) AC terminals observing that the "high" and "return" leads must be wired to the respective terminals. The system ground is connected to the GRD terminal associated with the AC input terminals.

2.3.6.2 Three-phase Units: All units which are specified in Table 1-1 as "208 volts, three-phase", are intended to be used with a four wire system with the neutral connected. The Outline Drawing indicated in Table 1-1 indicates the correct wire sizes to be used in wiring to the Phase A, Phase B, Phase C and Neutral terminals. In addition, the system ground must be connected to the GRD terminal associated with the AC input terminals. For those units where Table 1-1 specifies input of 460 volts three-phase or 220 volts three-phase three-wire, the system is a three wire system with no neutral. The connection is similar to that of the four wire system except that no neutral load is required.

2.3.7 Constant Current Connection:

Where specified in Section 1, some NJE Power Supplies may be converted to Constant Current Regulated supplies. Figure 2-1 provides information for making this reconnection. Since there are numerous possibilities and parameters which must be considered, the information provided must of necessity be limited. For special applications, consult the factory Application Engineering Department.

On those units equipped with variable current limiting overload protection (See Section 1), and where regulation requirements are restricted, Constant Current applications may be achieved directly without resorting to the more refined connection of Figure 2-1. This method of operation is described in Section 2-5.

2.4 DUALLING:

2.4.1 Cooling of Dual Unit Installation:

Where the dual units are to be rack mounted one directly above the other, the filler panels referred to in Air Flow specification per Paragraph 1.3 must be used. These panels may be ordered from NJE Corporation if the same finish is desired. For standard finish, 1-3/4" by 19" filler panels, order NJE Part No. 22164.

2.4.2 Series Connection:

Those NJE Power Supplies which may be connected in series, as indicated by the Dualling specification in Section 1, can be so connected using Figure 2-2A. If "S" option is required, the unit should be ordered specifying the "S" option. Where field connection is required, reverse voltage protection diodes must be installed to protect against reverse voltage during a short circuit on the series connected supplies.

These diodes should have a Forward Average Current rating equal to or greater than the output current rating of the supply and a Peak Inverse Voltage rating greater than the highest operating voltage of the application. The diodes must be connected in the nonconducting direction across the power supply output terminals. The series connection is quite straight forward and is essentially the same as connecting two batteries in series. Each supply is independently controlled and delivers an output voltage within its own capability. The total output voltage, is of course, the sum of that of the two supplies.

Connection of the series option, including the location of the reverse voltage protection diodes, is clearly shown in Figure 2-2A. The connection of the sensing leads is for the remote sensing mode of operation. If precise regulation at the load is not required, the sensing leads may be left jumpered at the respective output terminals as in Paragraph 2.3.3.

2.4.3 Parallel Connection:

Those NJE Power Supplies which may be connected in parallel, as indicated by the Dualling Specifications in Section 1, can be connected in parallel using Figure 2-2B. The total paralleled current must be derated by 10% from the individual current rating as the two supplies cannot be made to divide the load exactly.

2.5 OPERATION:

2.5.1 The following check list should be followed before making the unit operational:

2.5.1.1 AC power switch in the off position.

2.5.1.2 VOLTAGE ADJUST potentiometer in the extreme counterclockwise position.

2.5.1.3 CURRENT CONTROL$^{\Delta}$ potentiometer (where provided) in the extreme clockwise position.

2.5.1.4 Input wiring made per Paragraph 2.3.6.

$^{\Delta}$Specified as CURRENT ADJUST on some models.

2.5.1.5 Output Grounding wired per Paragraph 2.3.1.

2.5.1.6 Output wiring made per Paragraph 2.3.2.

2.5.1.7 Remote Sensing wiring made per Paragraph 2.3.3.

2.5.1.8 Output Capacitor wiring (where provided) made per Paragraph 2.3.4.

2.5.1.9 Remote Programming wiring made per Paragraph 2.3.5.

2.5.1.10 Constant Current wiring (where provided) made per Paragraph 2.3.7.

2.5.1.11 Dualling connection (where desired) made per Paragraph 2.4.

2.5.2 Step-by-step operation based on the location of controls as indicated on the outline drawing specified in Table 1-1:

2.5.2.1 Energize the AC line.

2.5.2.2 Operate the AC power switch to the ON position. The pilot lamp should light.

2.5.2.3 While monitoring both output voltage and current, slowly rotate the VOLTAGE ADJUST potentiometer clockwise until the desired voltage level is reached.

2.5.2.3.1 If the desired voltage and/or current level (within the ratings of the unit) cannot be reached, de-energize the AC line and re-check all connections per Paragraph 2.5.1 above. If still unable to achieve the desired levels, refer to the Troubleshooting Section at the rear of the manual.

2.2.4 CURRENT CONTROL (where provided) may be set to the desired level as follows:

2.5.2.4.1 Method #1: While monitoring the load current, apply a short circuit across the load and rotate the CURRENT CONTROL potentiometer counter-clockwise, until the desired current level is reached.

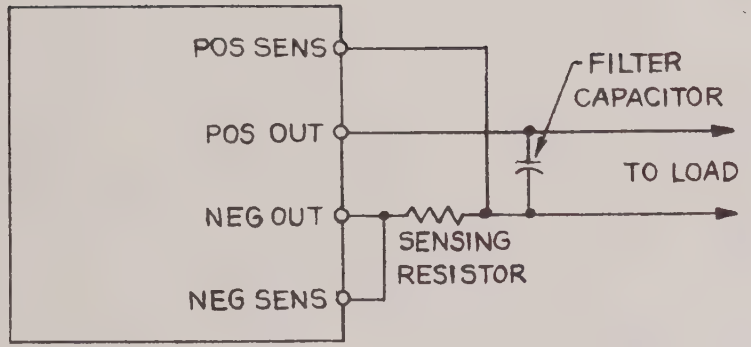
2.5.2.4.2 Method #2: While monitoring the load voltage and current, adjust the load so that the desired levels are reached. Rotate the CURRENT ADJUST potentiometer(s) slowly counterclockwise until the current level begins to fall off.

Where specified in Section 1, some units are provided with MODE lamps. When the above step is performed on these units, the voltage MODE lamp should extinguish and the current MODE lamp should light. A slight clockwise adjustment of the CURRENT CONTROL potentiometer will then set the current limiting just above the operating level. The VOLTAGE MODE lamp should now light and the CURRENT MODE lamp should extinguish.

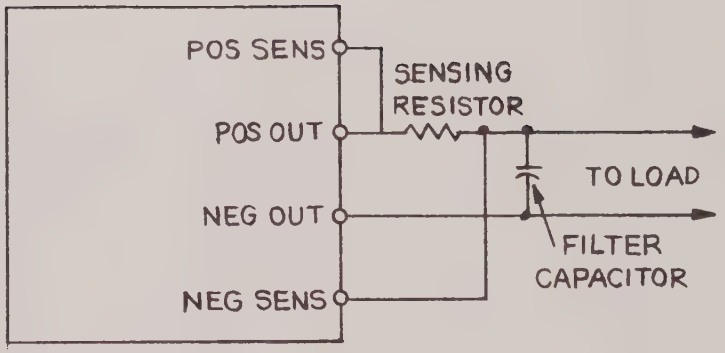
2.5.2.4.3 Method #3: Leaving the CURRENT CONTROL at the extreme clockwise position sets the current limiting action at approximately 110% of the maximum current rating of the supply.

NOTE 1: The current limiting feature is essentially a constant current device. As the load resistance is reduced toward an eventual short circuit condition, the load current will be limited to the present CURRENT CONTROL setting, and it will hold at this value as the output voltage falls toward zero. The current regulation is better than 5% as the load resistance varies to cause a full swing of output voltage and is proportionally better for smaller load resistance changes.

NOTE 2: For the RVC, RB and SVC Lines which are provided with both voltage and current regulation with automatic crossover circuitry, the current limiting characteristic described above is highly regulated. Actual current regulation parameters are in accordance with the specifications noted in Section 1.



ALL UNITS EXCEPT TC LINE



TC LINE ONLY

PROCEDURE

1. SENSING RESISTOR SHOULD BE SELECTED TO PRODUCE APPROXIMATELY 1 VOLT DROP AT MAXIMUM DESIRED CONSTANT CURRENT. RESISTOR WATTAGE SHOULD BE AT LEAST FOUR TIMES MAXIMUM DISSIPATION FOR CURRENT STABILITY. SEE NOTE 4.
2. FILTER CAPACITOR SHOULD BE 6-10 MICROFARADS, OIL OR TANTALYTIC, WITH VOLTAGE RATING GREATER THAN MAXIMUM DESIRED OUTPUT VOLTAGE.

NOTE 1: SEE OUTLINE DRAWING, SECTION I, FOR TERMINAL CONNECTIONS AND WIRE SIZES.

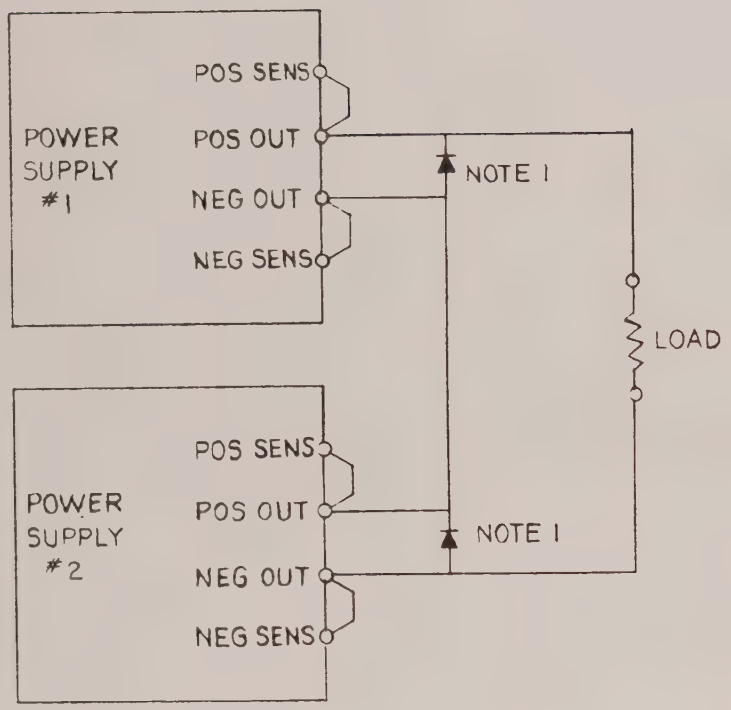
NOTE 2: ON TC UNITS, AN INTERNAL JUMPER BETWEEN TERMINALS 6 AND 11 ON PRINTED CIRCUIT BOARD A2 (96PC) MUST BE ADDED FOR CONSTANT CURRENT OPERATION.

NOTE 3: A POTENTIOMETER APPROXIMATELY 10% OF THE RESISTANCE OF THE OUTPUT ADJUST POTENTIOMETER SHOULD BE INSERTED IN THE PROGRAMMING TERMINALS. THE OUTPUT ADJUST SHOULD BE SET TO ITS MINIMUM POSITION. THE NEW POTENTIOMETER WILL THEN PROVIDE CURRENT CONTROL OVER THE DESIRED RANGE. IF DESIRED, THE OUTPUT ADJUST ITSELF MAY BE USED FOR CURRENT CONTROL, BUT ONLY THE LOWEST PORTION OF THE POTENTIOMETER IS USED. IF AVAILABLE ON THE SUPPLY, THE FINE CONTROL CAN PROVIDE ADEQUATE RESOLUTION.

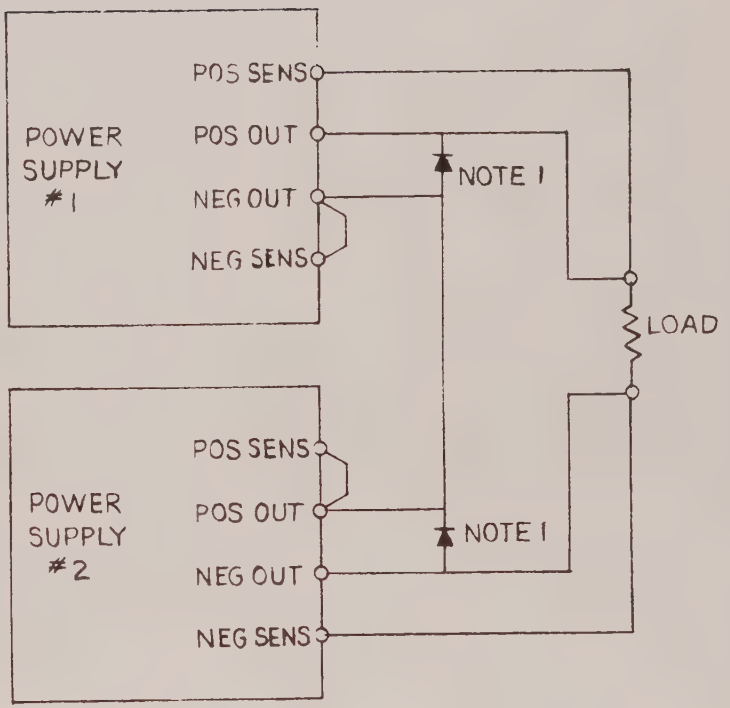
NOTE 4: LOW TEMPERATURE COEFFICIENT RESISTORS WILL IMPROVE STABILITY.

CONSTANT CURRENT CONNECTION

FIG. 2-1



LOCAL SENSING



REMOTE SENSING

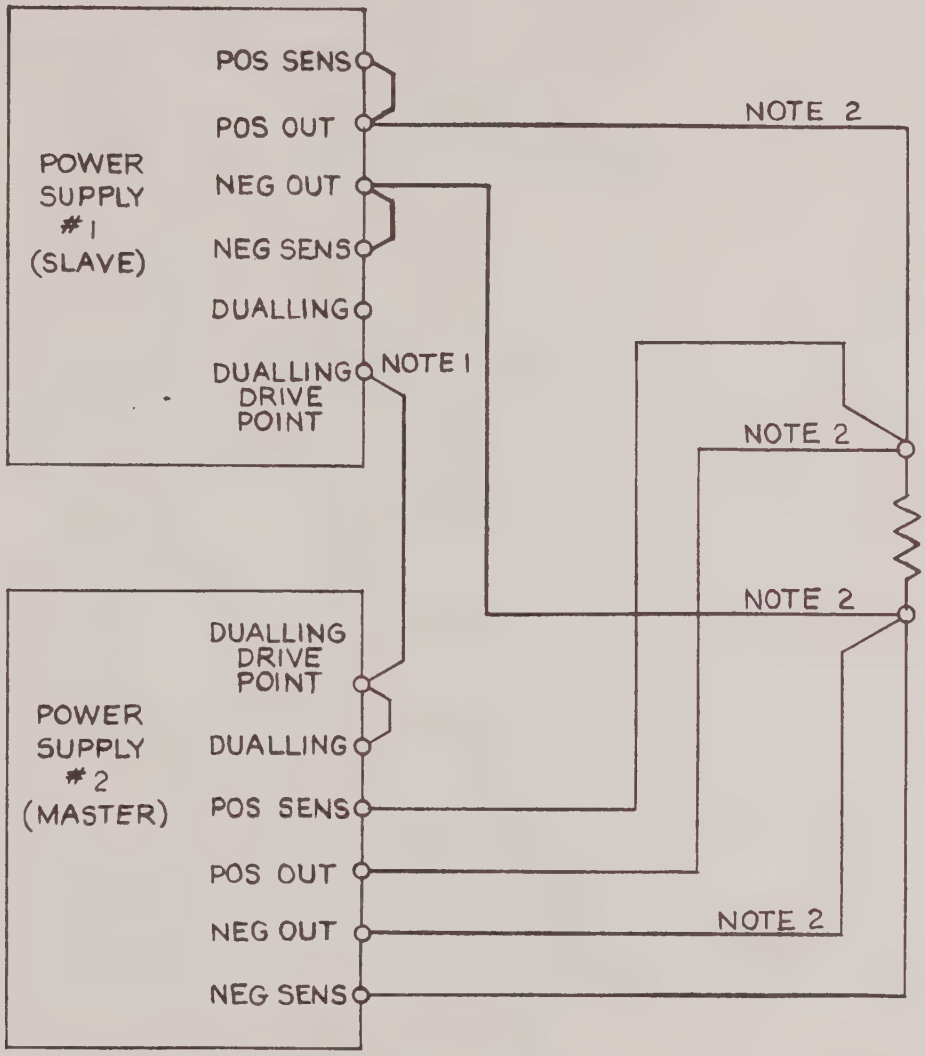
NOTE 1: REVERSE VOLTAGE DIODE, AS REQ'D. SEE PARA. 2.4.2
SEE OUTLINE DRAWING, SECTION I, FOR TERMINAL CONNECTIONS AND WIRE SIZES.

SERIES CONNECTION

FIG. 2-2A

103949

801578



NOTE 1: JUMPER REMOVED FROM DUALLING TERMINALS ON "SLAVE" UNIT. INTERCONNECT DUALLING DRIVE POINTS BETWEEN "MASTER" AND "SLAVE" UNIT. SEE OUTLINE DRAWING, SECTION I, FOR TERMINAL CONNECTION AND WIRE SIZES, INCLUDING DRIVE POINT.

NOTE 2: LOAD LINE RESISTANCES SHOULD BE BALANCED CLOSELY FOR OPTIMUM OPERATION.

PARALLEL CONNECTION

FIG. 2-2B

SECTION III

THEORY OF OPERATION

3.1 GENERAL:

A simplified block diagram illustrating the basic elements of the circuit and the signal flow is shown in Figure 3-1. The AC line voltage is transformed to adequate values to supply the main output rectifiers through the main transformer and is filtered by a capacitor input filter. The transistor amplifier voltages are obtained from the auxiliary transformer winding and an associated AC to DC rectifier and filter system. In the constant voltage mode, the output voltage furnished to the load by the series regulator is monitored by a feedback amplifier, which compares this voltage with a stabilized reference voltage, and amplifies the difference between the two voltages. The output of the amplifier is used to control the series regulator in such a way that it counteracts any change in the DC output voltage, thereby furnishing an essentially constant voltage to the external load. In the constant current mode, the output current furnished to the load by the series regulator is monitored by a second feedback amplifier which compares the voltage drop across a series resistor with a stabilized reference voltage and amplifies the differences between the two voltages. The output of this amplifier follows the same control path as the constant voltage mode and is used to control the series regulator in such a way that it counteracts any change in the DC output current thereby furnishing an essentially constant current to the external load.

3.2 DETAILED CIRCUIT DESCRIPTION:

Circuit references in the following material apply to the schematic diagram at the back of the manual. This diagram shows electrical relationships, and is laid out in an arrangement approximately the same as that of the Block Diagram, Figure 3-1.

3.3 The power supply is energized by connecting 115 volts (nominal) 60 cycles, single phase, to the input terminals and closing switch (S1), attested by the lighting of pilot lamp (DS1) and starting of fan (B1).

3.4 The power transformer winding (T1) converts the input line voltage to an appropriate value, which is rectified to a pulsating DC output voltage by rectifier assembly (CR1 and CR2). The DC voltage is then filtered by capacitor (C1) and applied through regulating transistor assemblies (A2 and A3) to the external load. Capacitor (C12) provides additional filtering of the output, and reduces the internal impedance of the supply for medium frequency load variations.

3.5 A positive bleeder bias source is provided by the rectification action of rectifiers (CR3) and (CR4) on the main transformer winding and the filtering action of capacitor input filter (C2). (R4) is the bleeder resistor for the main power supply and provides a minimum current flow for the series regulators.

3.6 The output voltage on the transformer auxiliary (AUX) winding is rectified by diodes (CR5) and (CR6) and filtered by capacitor input filter (C3) to provide positive and negative amplifier bias voltages. The positive voltage is regulated by the breakdown diode (CR7) to provide ± 5.6 volts.

3.7 Negative amplifier bias voltage is regulated by a series regulator transistor (Q3) which is controlled by a single stage of transistor amplification (Q2). The negative voltage of approximately -20 volts is achieved at series regulator output capacitor (C5) through the action of the resistor divider consisting of (R17) and (R18) connected across the outputs of the positive and negative bias points and feeding the base of the amplifier stage (Q2). Capacitor (C4) provides high frequency feedback for the negative bias amplifier loop.

3.8 The main feedback amplifier loop which is common to both voltage and current modes consists of three stage of amplification; the first two of these are balanced differential amplifiers, assuring minimum sensitivity to fluctuations in ambient temperature or operating voltages. The input signal for the amplifier is derived from either a voltage sensing divider connected across the output of the supply or the current sensing pre-amplifier. Diode (CR11) is connected at the base of (Q13) to provide protection for the transistor differential amplifier during surges arising from transient load conditions.

3.9 The output voltage divider consists of fixed resistor (R38) and Voltage Range Adjust adjustable resistor (R37) in the amplifier circuit board, and VOLTAGE ADJUST dual potentiometer (R2) on the front panel. The positive end of this divider is connected to the positive sensing terminal and the resistance setting of variable resistor (R2) determines the operating value of the DC output voltage of the supply in a manner which will be explained below.

The variable resistor (R2) is a dual potentiometer connected concentrically to the VOLTAGE ADJUST COARSE-FINE knob on the front panel. (Some models use a 10-turn potentiometer.)

3.10 The output current sensing voltage is developed across power resistor (R10) in series with the negative output terminal of the supply. The output current signal is fed to the current pre-amplifier balanced input stage (Q4) and (Q5) by means of the divider consisting of fixed resistor (R22) and Current Range Adjust adjustable resistor (R23) in the amplifier circuit board, and CURRENT CONTROL potentiometer (R1) on the front panel. The resistance setting of variable resistor (R1) determines the value of the DC output current of the supply in a manner which will be explained below.

3.11 The breakdown diode, (CR10) in conjunction with its load resistor (R36) provides a highly stable potential of -5.6 VDC for use as comparison voltage by the input stage (Q12 and Q13) of the feedback amplifier loop. One end of the reference is directly connected to the negative sensing terminal. When the output voltage or current of the power supply (measured at the load) is precisely at its selected nominal value, the voltage at the base of transistor (Q13) is at the same level as the base of transistor (Q12) and the input stage is in balance. Under this condition, any tendency of the load current or voltage to vary in either direction will unbalance the amplifier, resulting in corrective action which compensates for the change, and holds the load current or voltage at its established value, as explained below.

3.12 Transistor (Q12 and Q13) are NPN type units, operated in common emitter mode and connected as a balanced differential amplifier. Their outputs, taken across load resistors (R33 and R34), are direct-coupled to the bases of the succeeding differential amplifier stage (Q10 and Q11) which consists of two PNP transistors operated in common-emitter mode. The output of transistor (Q10), from its load resistor (R32) drives the base of the single ended emitter follower stage (Q9). The output of the amplifier is tied directly to the base of the driver transistor (Q8).

3.13 Current and voltage regulation of the DC output is performed by a transistor series regulator consisting of power transistors on the heat sink assemblies (A1 and A2) operating in parallel, providing high-speed regulating action to correct for ripple and transient variations both at its input (across C1) and at the output of the supply. The amplifier loop provides correction signals to the series regulator from signals derived from the output voltage and current.

3.14 The regulating principle of the series regulator feedback loop is to maintain balance at the base of transistors (Q12 and Q13). These bases will maintain balance within a small voltage which is the error voltage due to feedback loop gain level. Due to the high gain of the system, the error voltage will be small, and at most is equal to the maximum allowable error of the equipment.

The sequence of operation begins by adjustment of variable resistor (R2). This change will unbalance the base of transistor (Q13) with respect to transistor (Q12) base. The system will adjust itself up or down until the voltage levels at both bases are equal. One such action will be described. Other disturbances cause the circuit to react in a similar manner.

If we wish to raise the output voltage, then the value of VOLTAGE ADJUST (R2) is increased. This increase momentarily decreases the voltage at the base of (Q13). The error is amplified through the system and a signal is applied to the base of the series regulator transistors in such a manner as to decrease its storage voltage. The sensitivity and speed of response of the corrective feedback loop is such that the above-described action occurs almost instantaneously and the actual excursion of the load voltage is held to a very small value. The circuit is a true proportional regulator and must allow a small but finite "error" to exist between the required and actual regulated voltage, so that this error, however small, can generate the corrective signal. By proper circuit design, however, the error is held to a value which remains within the specified regulation allowance of the power supply.

When the variable resistor (R2) is readjusted to produce a different value of output voltage, the circuit makes a correction similar to that described above. Altering the resistance in the sensing voltage divider unbalances the input stage of the feedback amplifier, which then causes the circuit to produce a new value of voltage such that the drop across the resistors (R37) and (R38) again equals the drop across breakdown diode (CR10). Reducing the value of the variable resistor

3.14 (cont'd)

(R2), for example, momentarily increases the drop across resistors (R37 and R38). However, this unbalanced condition at the amplifier input causes the DC output voltage to decrease until the drop across resistors (R37 and R38) again equals the drop across breakdown diode (CR10) and the circuit stabilizes at this new operation point, establishing a lower value of DC output voltage.

3.15 Variable resistor (R37) in the amplifier is provided to permit compensation for manufacturing tolerances in breakdown diode (CR10), its load resistor (R36), and voltage feedback resistors (R2) and (R38).

This resistor is adjusted for proper range of controls at the factory (and locked). If any of these components are replaced, a readjustment of (R37) may be necessary. See Maintenance Section IV for the proper procedure for this readjustment.

3.16 The operation of the current regulator pre-amplifier is accomplished by means of the following circuitry. Voltage at the base of transistor (Q4) is established by the setting of CURRENT CONTROL potentiometer (R1). The voltage at the base of transistor (Q5), the other half of the current regulation differential pair, is established by the voltage drop across current sensing resistor (R10). As load current increases to the value selected by the CURRENT CONTROL setting, the base voltage at (Q5) continues to approach the voltage at (Q4). When the load current reaches the value of the Current Control setting, the bases will be exactly in balance, and the next stage of the pre-amplifier (Q6 and Q7) is effectively "turned on". At this condition, diode (CR9) conducts and the base of (Q9) is clamped, thus overriding the voltage amplifier control. The action is quite sharp once conduction begins. Prior to conduction, the diode (CR9) effectively decouples the current regulating pre-amplifier from the main amplifier. The circuitry described in this paragraph is often referred to as "Automatic Cross-over". Because of the decoupling circuit property of diode (CR9) either the voltage amplifier is operating, or the current pre-amplifier is operating, but not both. Thus, in the region in which load current magnitude is lower than that of the Current Control setting, the diode decouples the current regulator. The power supply is in the voltage regulating mode, and the load current adjusts itself to the dictates of the load circuitry. In the region in which load current magnitude has achieved a value equal to the Current Control setting, the diode conducts and overrides the voltage regulator. The power supply is in the current regulating mode, and the output voltage adjusts itself to the dictates of the load circuitry.

3.17 Variable resistor (R23) in the amplifier is provided to permit compensation for manufacturing tolerances in breakdown diode (CR10), the current sensing resistor (R10), and the CURRENT CONTROL components (R1), (R22). If any of these components are replaced, a readjustment of (R23) may be necessary. See Maintenance Section IV for proper procedure for this readjustment.

3.18 Meter calibration circuitry is provided to adjust the full scale voltage and current indications on meter (M1). Switch (S2) connects the meter either into the voltage monitoring position across the voltage sensing terminations of the supply, or the current monitoring position across the current sensing resistor (R10). As a voltmeter, (M1) utilizes a multiplier resistor (R16) and calibration resistors (R14 and R15). As an ammeter, (M1) utilizes current calibration resistors (R11 and R12).

3.19 Turn-off overshoot is prevented by transistor (Q1). When AC line power is removed, the bleeder bias supply at (C2) which has relatively little stored energy, collapses rapidly. The resistive voltage divider consisting of resistors (R2) and (R6) causes a negative going voltage to appear at the base of transistor (Q1) sufficient to "turn on" the transistor. This then produces additional cut-off current for the main series transistors through resistor (R39) and for the driver transistor through resistor (R40).

9/9108

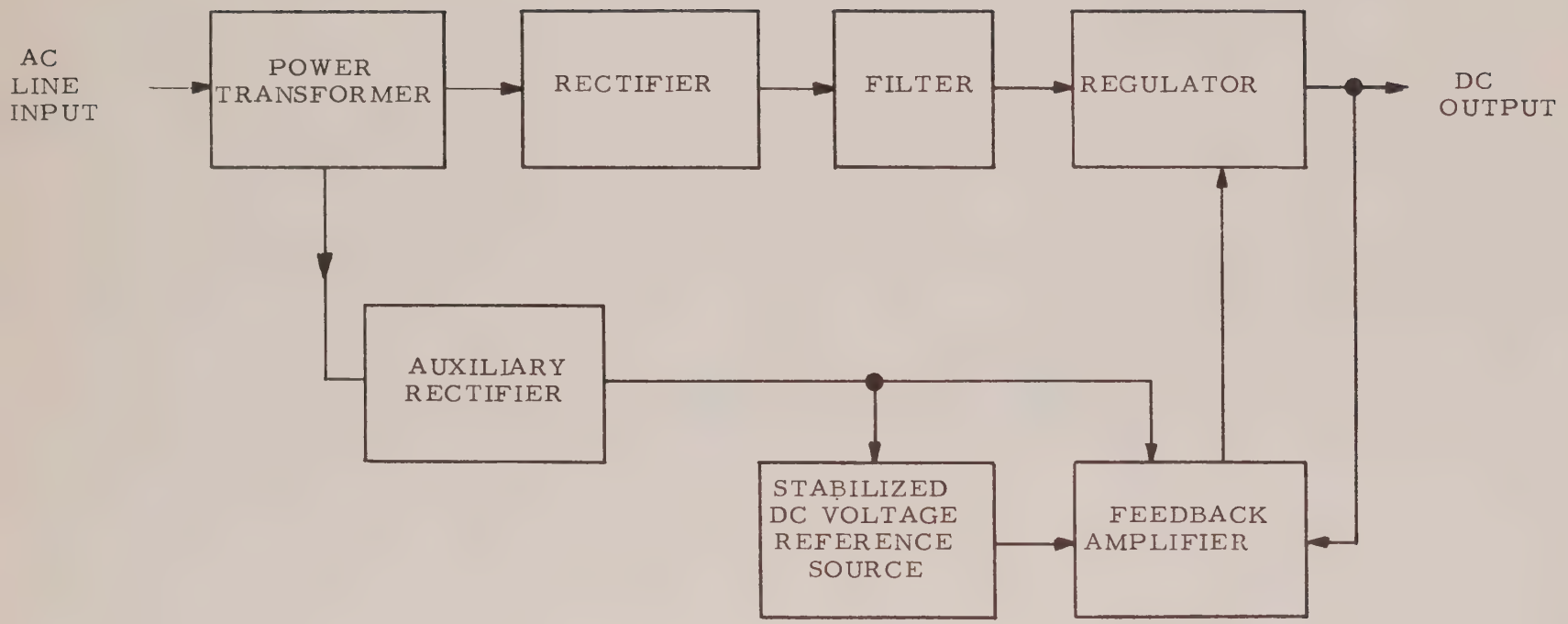


Figure 3-1

Simplified Block Diagram

NJE Dwg. No. 104043

SECTION IV

MAINTENANCE

4.1 GENERAL: Reference drawings for this power supply are provided in Section V. The exact Schematic Drawing is shown in Figure 5-1. Physical location of components is indicated in the Parts Placement Drawing in Figure 5-2.

This supply is designed for stable operation over long periods of time. However, if trouble develops, standard test equipment normally found in the Electronics Laboratory would be required. If the customer decides to do complete servicing on his premises, one or more of the following pieces of test equipment are required:

Instrument	Range	Remarks
DC Differential Voltmeter	0-500V	Precise Regulation check
Oscilloscope	General Purpose	General troubleshooting
Vaccuum Tube Voltmeter	General Purpose	Ripple measurements
Multimeter (Ohmmeter)		General troubleshooting
AC Voltmeter (precision)	0-150V	Precise regulation check
Variable Autotransformer	Per input rating	General troubleshooting
Dummy Load	Range depends on supply rating	

WARNING!!!

THE POWER SUPPLY SHALL BE DE-ENERGIZED WHENEVER ANY COMPONENTS ARE REPLACED.

4.2 PREVENTATIVE MAINTENANCE:

The principle item that will require attention is the cooling arrangement. The power supply generally requires some amount of convection air currents for cooling purposes. These supplies make use of internal forced air cooling. It is important to keep the rear of the unit clear of obstructions which might reduce the effectiveness of the fan.

CAUTION ! !

VACUUM CLEANER MAY LOOSEN THE

SMALL PLUG-IN TRANSISTORS.

4.3 MEASUREMENTS AND TESTS:

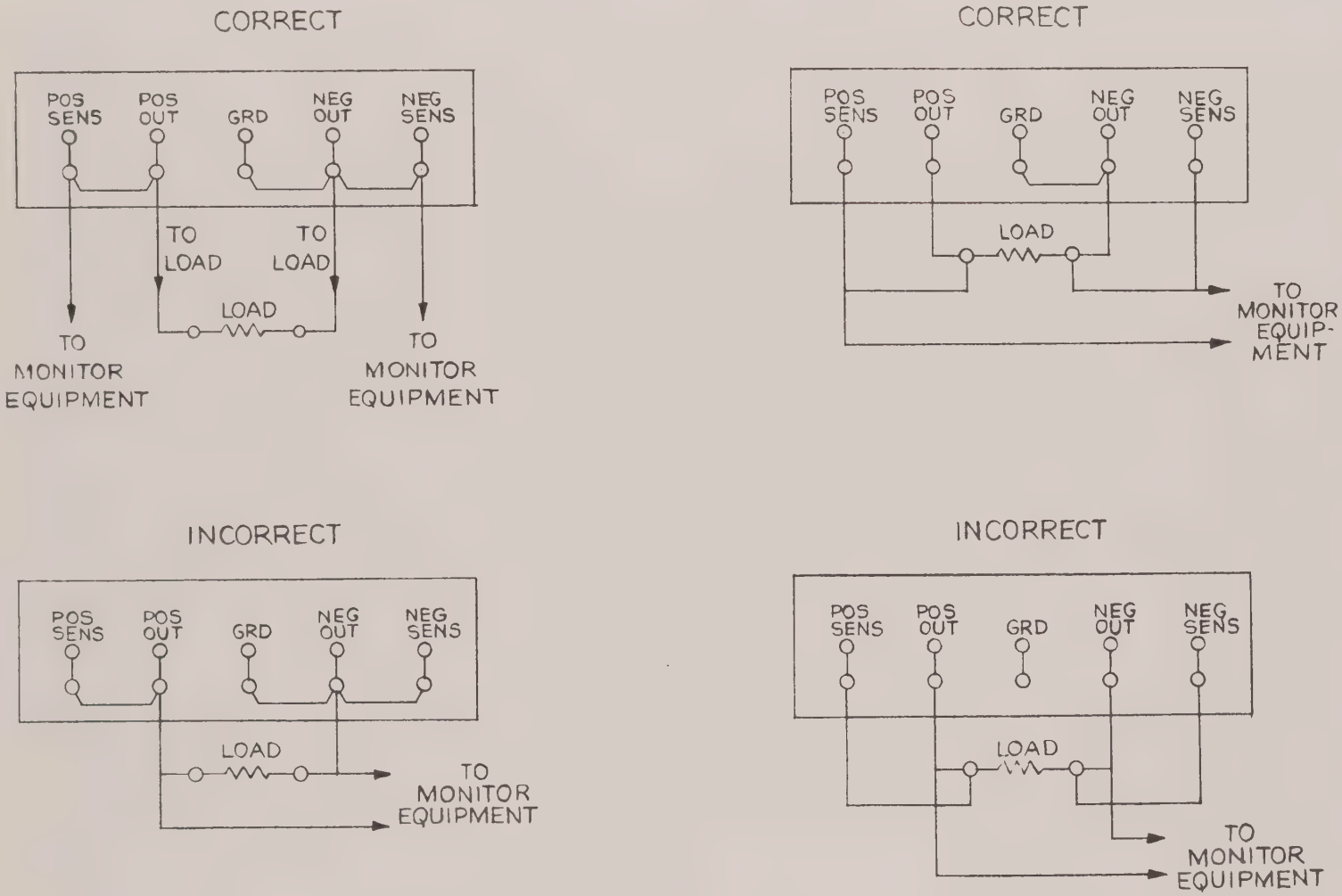
4.3.1 Sensing Connection: Sensing lead connections are of utmost importance in making proper regulation measurements. It is recommended that the sensing connections be made directly at the output terminal points rather than at a remote load point. Although the regulation measurement should check correctly at a remote point as well as at the supply terminals, it is well to ascertain that the power supply itself is operating properly without introducing the possibility of extraneous external wiring problems. Thus, all measurements should be made with "local" sensing connections, i.e., with the sensing terminals jumpered directly to the corresponding output terminals. One other point of caution in proper measurement technique is the following:

> It is absolutely essential that the measuring equipment connections be made directly to the sensing terminals, whereas the load lead connections must be made directly to the output terminals. Figure 4-1 shows proper and improper connections for measurements taken with "local" and "remote" sensing connections.

Various measurements can be made using essentially the same connections, but using different instrumentation. The following paragraphs describe the basic parameters which may be tested.

4.3.2 Regulation checks: Since regulation of modern power supplies can be as low as 0.001%, special measuring techniques must be employed to accurately check the various regulation parameters. It is necessary to use an external source of DC voltage of approximately the same value as the power supply output as a "bucking" source, connected as shown in Figure 4-2. This DC bucking voltage can be either an electronic, null balance differential voltmeter, or a group of batteries connected in series (or another power supply), furnishing a DC potential slightly larger than the output voltage of the power supply under test. When using a differential voltmeter, the voltmeter is built right into the test equipment. When a "bucking" battery is used, the voltmeter should have a full-scale range low enough to detect the magnitude of regulation expected.

A multi-tester used on the 1 volt range will usually be adequate, since approximately 10 millivolts can be observed reasonably well. The point to note here is that the voltmeter is used to measure only the difference between two almost equal voltages. The balance adjustment (either in the electronic unit, or the test set-up of the diagram) is used to bring the meter needle to approximately midscale before testing, so that the deviation above or below the normal output fo the supply under test can be observed.



MEASUREMENT CONNECTIONS WITH LOCAL SENSING AND REMOTE SENSING

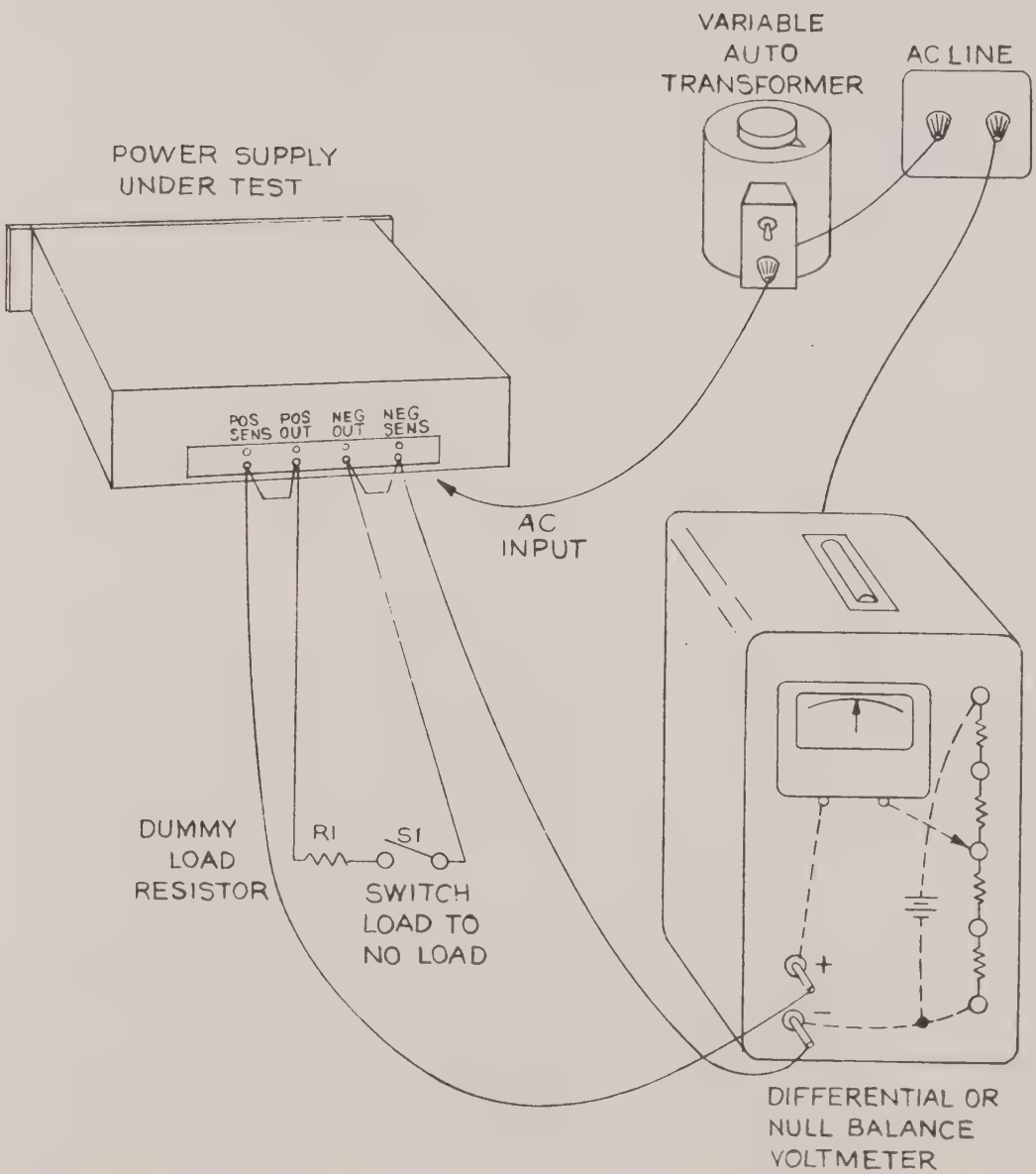
4.3.3 Static Load Regulation: The dummy load (R1) of Figure 4-2 is selected to draw full load current at the nominal output voltage of the supply. The difference between the differential voltmeter readings with the switch open and closed (allowing the needle to come to rest before reading), gives the static load regulation in volts. When load changes are made, it may be necessary to readjust the line voltage to its nominal value.

4.3.4 Static Line Regulation: With the load set at some fixed value, either no load, full load, or some in-between point, the input line is varied by means of the variable auto-transformer shown in Figure 4-2. Note that if this measurement is made under a heavy load condition, the auto-transformer must be selected to supply the necessary input volt-amperes. The difference between the differential voltmeter reading for different line voltage conditions (allowing the needle to come to rest before reading), gives the static line regulation in volts.

4.3.5 Ripple: Either a sensitive VTVM or oscilloscope may be connected directly across the power supply sensing terminals for this measurement. The same set-up is used for the regulation checks may be used if it is desired to observe the ripple under different conditions of the voltage and load current. Be sure to make the measurement connections at the sensing terminals rather than at the load terminals.

4.3.6 Dynamic Regulation and Recovery Time: In the test set-up described above for Static Load or Line Regulation, a calibrated oscilloscope should be substituted for the differential voltmeter. Maximum deflection and recovery time are measured directly, as a dummy load of appropriate value is switched in and out of the circuit. A mercury switch is recommended to minimize arcing, or else an electronic switch should be used. If available, the latter is highly desirable, since the response is readily displayed on the oscilloscope. If the rise and fall time of the current step be at least five times faster than the anticipated recovery time.

4.3.7 Stability: A detailed check for improper drift and intermittent failure can be made by utilizing the same test arrangement as for static regulation measurements. The only requirement is that the differential voltmeter used must have stability of an order of magnitude better than that of the power supply. If available, a stable recorder may be substituted for the differential voltmeter in the drawing, thereby procuring a continuous tracing of the power supply stability.



REGULATION CHECK
TYPICAL LAYOUT

FIG. 4-2

4.4 TROUBLESHOOTING:

There are various types of trouble possible with this supply. The following procedure tabulates the most likely types of trouble.

CAUTION: The sensing terminals (TB1-1 and TB1-5) must always be crossconnected to the output voltage. Failure to observe this rule will result in catastrophic failure of the power supply.

NO OUTPUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Fuse blown.	Shorted component	Check the unregulated DC sources (Main, Aux.) and localize trouble.
Fuse not blown.	Defective transistor or component in rectifier-filter section or pass section.	Check for open circuit component.

LOW VOLTAGE OUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Voltage movable.	Defective reference diode	Perform stability tests of Par. 4.7.
Voltage stable.	Defective component on PC subassembly.	Check storage voltage across series pass transistors and if high, check error amp.

HIGH VOLTAGE OUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Constantly high voltage.	Defective component on PC subassembly.	Check storage voltage across series pass transistors. If low, check error amp.

TROUBLESHOOTING (cont'd)

NC REGULATION

SYMPTOM	POSSIBLE CAUSE	REMARKS
Do not operate unit until the sensing terminals are checked for proper connections		

POOR REGULATION

SYMPTOM	POSSIBLE CAUSE	REMARKS
Regulation poor under load or line changes	Defective transistor or component on PC sub-assembly	

4.5 ALIGNMENT AND ADJUSTMENT:

The power supply has four controls that are factory adjusted and normally do not require attention in the field. If any of the components in the error-difference amplifier are replaced or the ammeter or voltmeter requires calibration the following readjustment procedure may be necessary.

4.5.1 OUTPUT ADJUST calibration.

Step 1: Set OUTPUT ADJUST variable resistors (R2A and B) completely clockwise. The unit may be operated at nominal line and at no load.

Step 2: Place calibrated voltmeter across output.

Step 3: Adjust variable resistor (R37) until full rated output is reached.

4.5.2 CURRENT CONTROL calibration.

Step 1: Set OUTPUT ADJUST variable resistors (R2A and B) completely clockwise.

NOTE: Verify that the output is the full rated voltage.

Step 2: Set CURRENT CONTROL variable resistor (R1) completely clockwise.

Step 3: Short circuit output through a calibrated ammeter.

Step 4: Slowly rotate variable resistor (R23) until current level reaches rated value.

4.5.3 VOLTMETER calibration:

Step 1: Set OUTPUT ADJUST variable resistors (R2A and B) until front panel voltmeter (M1) reads full scale. Switch (S2) must be in VOLT position.

Step 2: Connect a voltage monitor to the sensing terminals.

Step 3: Adjust VOLTMETER CALIBRATION ADJUST (R15) until unit meter agrees with external calibration meter.

4.5.4 AMMETER calibration:

Step 1: Set OUTPUT ADJUST variable resistors (R2A and B) completely clockwise.

Step 2: Set CURRENT CONTROL variable resistor (R1) completely clockwise.

Step 3: Set switch (S2) to AMP position.

Step 4: Short circuit output through a calibrated ammeter.

Step 5: Adjust AMMETER VALIBRATION ADJUST (R11) until unit meter agrees with external calibration meter.

4.6 ERROR-DIFFERENTIAL AND SECONDARY REGULATION AMPLIFIER CHECK:

There are several methods which can be used in checking the performance and condition of these amplifiers.

Except for individually removing the transistors for a check by means of a transistor test set, and making continuity and resistance tests on the circuit and components, all methods require the amplifier to be energized with the proper potentials under the conditions found in the power supply for normal operation. For this reason, it is simpliest to test the amplifier in position in the supply, first making certain that the unregulated DC bias sources are functioning properly. This can be quickly ascertained by checking the circuit voltages on the schematic diagram Figure 5-1. Once this is done, the procedure given below can be used to check out the amplifiers.

4.6.1 Signal Tracing Check:

Since there is an inherent amount of ripple at the input of the amplifiers, this ripple signal can be used as a test signal for observing the amplifier performance with the aid of a test oscilloscope. (Ignore any spikes in the waveform.) Use only the basic ripple signal when making amplitude calculations. In the event that the ripple is too small for practical use, a small 60-cycle sine wave voltage of convenient amplitude (less than 0.1 volt) can be injected into the amplifier by applying it to the base of the input transistor (Q13) on the printed circuit board. Measurement of the ripple at the input to the amplifier, and at the output of each successive amplifier stage will provide an effective check of amplifier performance. The ripple amplitude measured at the base (or input) of the second stage transistors (Q10 and Q11) should be 40 to 100 times the amplitude at the input to the first stage. Radical departure from this set of conditions will point up a defective component or connection, which can then be isolated by inspection and individual test. Be sure not to overdrive the amplifier stages as it will cause misleading results. This process can be continued until the emitter follower stages are reached. At this point the circuitry undergoes an impedance transformation and no voltage gain will be noted. Instead a decrease in amplitude will be noted.

4.7 STABILITY CHECK:

A detailed check for improper drift and intermittent failure can be made by utilizing a test arrangement similar to that shown for regulation check in Figure 4-2.

NOTE: Observe polarity of setup as required.

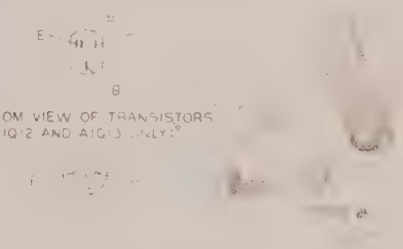
The voltage across the breakdown diode reference source (A1CR10) is "bucked out" and monitored by a 0 to 10 millivolt (or smaller scale, if available) high impedance DC voltmeter (null balance voltmeter). Drift or random instability will be readily visible in this test. Output voltages of the successive amplifier stages can then be monitored in the same manner. When checking a given amplifier stage by this method the output of the previous stage should be shorted, to prevent

4.7 (cont'd)

external voltage variations from reaching the stage under test. This does not include shorting the output terminals of the power supply. Care must be exercised to guard the load circuit from extraneous fields. When installing a new transistor in place of one shown to be defective, the stability check should be repeated to make certain that the trouble has been eliminated.

NOTES:

1. REFERENCE DESIGNATIONS ARE ABBREVIATED AND SHALL BE PREFIXED AS REQUIRED BY UNIT DESIGNATIONS AS SHOWN IN TYPICAL EXAMPLE.
2. ALL RESISTORS ARE 5% UNLESS OTHERWISE SPECIFIED.
3. TOP VIEW OF ALL TRANSISTOR SOCKETS.



BOTTOM VIEW OF TRANSISTORS
A1Q12 AND A1Q13 ONLY.*

MAIN
PI
150
10W
103232
103232

REVISIONS
A REVISED 5/11/64
B ECO 5594
C ECO 5955/56
D ECO 5887 10/20/64 GS
E REVISED 2-5-65
C12 3,350UF EA @ 50V IN PAR.
R16 10K 5%
TB1
OUTPUT
R 2 330 3W
R 1 10K 3W
VOLT METER CALIBRATION ADJUST
M1
S2
R19 160 3W
C13 2.5UF
COARSE
R2A 7500 2W
OUTPUT VOLTAGE ADJUST
R2B
CR1 1N538
R43 270 1.2W
CR14 1N9
CR10 1N983A BREAKDOWN VOLTAGE 6.6V
C14 25UF 50V
R1 1000 0% 2W
OUTPUT CURRENT ADJUST
1200 3W

400219

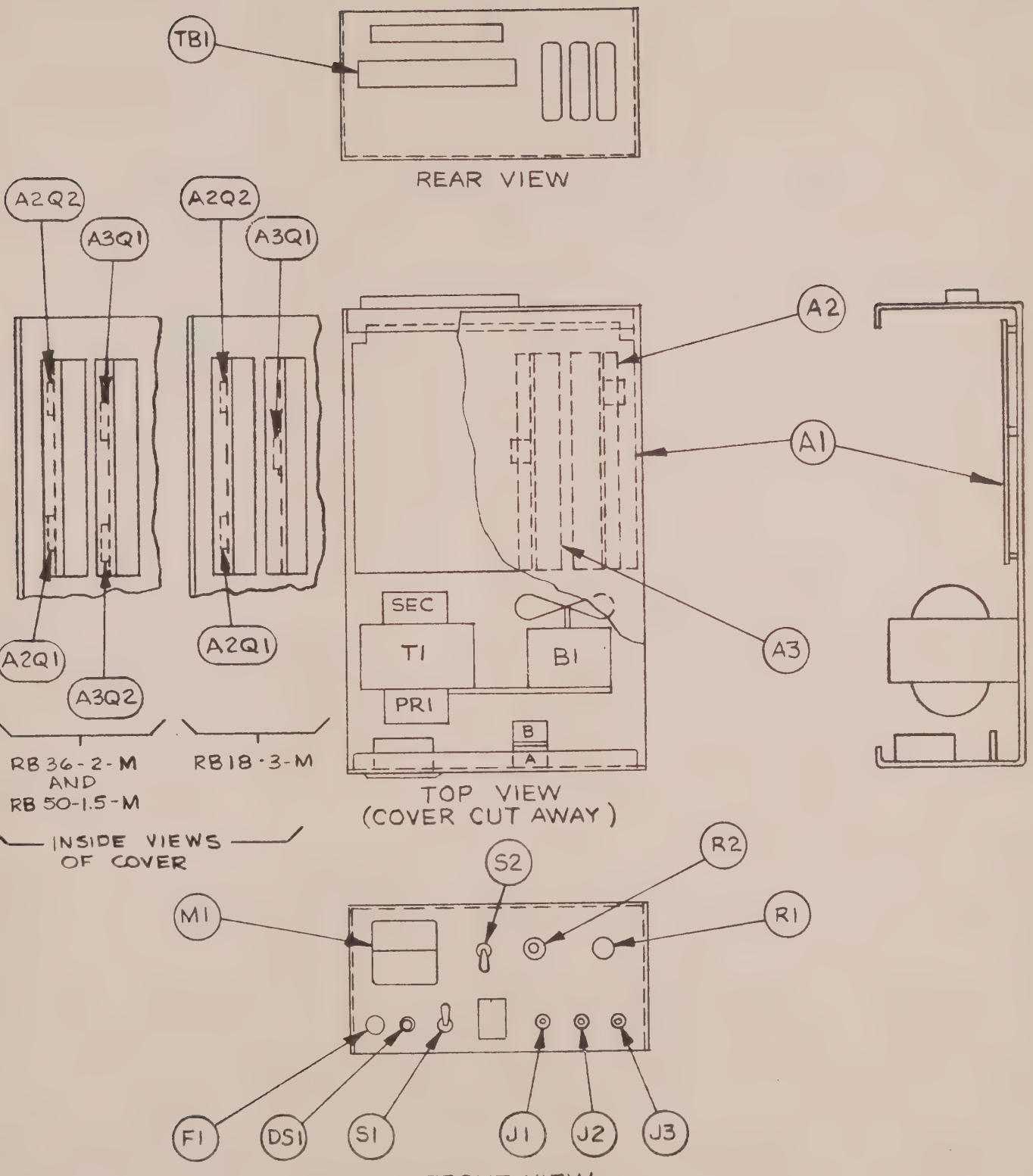
NOTES:

1. REFERENCE DESIGNATIONS ARE ABBREVIATED AND SHALL BE PREFIXED AS REQUIRED BY UNIT DESIGNATIONS AS SHOWN IN TYPICAL EXAMPLE.

2. ALL RESISTORS ARE 5% UNLESS OTHERWISE SPECIFIED.

3. TOP VIEW OF ALL TRANSISTOR SOCKETS

BOTTOM VIEW OF TRANSISTOR
A1Q12 AND A1Q13 ONLY.



PARTS PLACEMENT
RB LINE

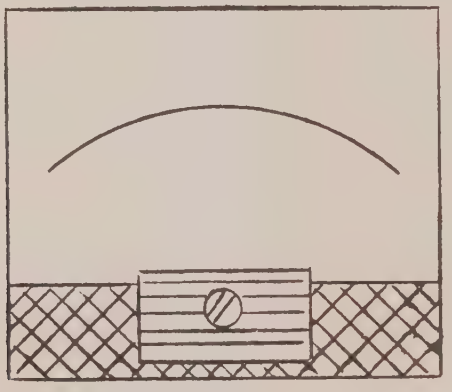
FIG. 5-2

DEVIATION NOTICE

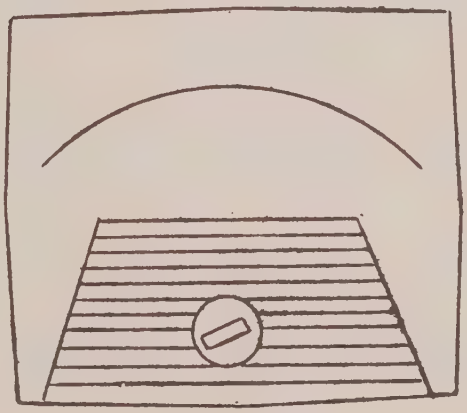
FOR SPARE PARTS

WHEN ORDERING A REPLACEMENT VOLT-AMMETER, REFERENCE DESIGNATION M1, YOUR ATTENTION IS DIRECTED TO THE METER FACE OUTLINE AS VIEWED FROM THE FRONT PANEL.

THE OUTLINE INFORMATION INDICATED BELOW SHOULD BE USED FOR SPECIFYING THE NJE PART NO. APPLICABLE TO THE POWER SUPPLY MODELS INDICATED.



REF. DESIG	MODEL	M1 NJE PART NO.
M1	RB-18-3	105373
M1	RB-36-2	105374
M1	RB-50-1.5	105375



REF DESIG.	MODEL	M1 NJE PART NO.
M1	RB-18-3	110443
M1	RB-36-2	110444
M1	RB-50-1.5	110445

802282

NJE DWG. No. 110685

ABBREVIATIONS USED IN SPARE PARTS LIST

In DESCRIPTION Column: "SA" is used to mean "Same As" and "PO" is used to mean "Part Of". Where these symbols are used, the UNIT QTY., SPARE QTY., UNIT PRICE and NJE PART NO., columns are all blank.

In VALUE Column: The use of the letter "R" to indicate a decimal point is illustrated by the following examples: 5.6Ω is written as 5R60K. 1/2 watts is written as R500 W. The use of zeroes does not imply a precision to the indicated number of decimal places but is a requirement of the proper handling of the Data Processing Cards from which these spare parts lists are written.

The standard symbols for electrical units are used and usually appear in the columns immediately to the left of the dashed and solid lines in the Value field. In all cases, the symbol "Ω" is not printed for resistors and is understood. For example: 200Ω is written 200 and 2.7MΩ is written 2R70M.

In REFERENCE DESIGNATION Column: The reference designations are those which interrelate the Spare Parts List, the Schematic Diagrams and the Parts Placement drawings. The symbols are those of MIL-STD-16. Where the reference designation is an "A" (meaning a sub-assembly), a Spare Parts List bearing the NJE Part Number of that assembly is included in the Spare Parts List section.

Deviations: Where minor deviations are accomplished by modifying a standard unit, a Spare Parts List which only shows the deletions and additions from the enclosed standard Spare Parts List is used.

N J E Corp. KENILWORTH, N.J.

Spare Parts List

MODEL BR1.5 C-M

PAGE NO. 84061

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*	NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
A1	PC 3		21794	1	1	
A2	PB ASSY		21830	1	1	
A3	MB ASSY		21757	1	1	
T1	LOWER 60 CPS	115V 1PH 3IN	227	1	1	13.50
F1	FUSE CARTRIDGE	2R00 A 250 V	25	1	5	.40
J1	CONNECTOR RECEPT	1 PIN 15 A	20857	1	1	1.00
J2	CONNECTOR RECEPT	1 PIN 15 A	20861	1	1	1.00
J3	SA J2					
M1	VOLT AMMETER DUAL	60V&1R5A 1MA	11044	1	1	36.00
R1	RES VAR WW	1R00 K 2 W	190	1	1	2.25
R2	RES VAR WW DUAL	7R5K&250 2	102129	1	1	5.00
S1	SWITCH	SPST 15 A	20601	1	1	1.50
S2	SWITCH	DPDT 15 A	5073	1	1	1.25
T1	XF & BKT ASSY		81350	1	1	
TB1	TERMINAL BOARD	12 TERM 15 A	124	1		1.68
XDS1	LAMPHOLDER	SL RED 115 V	20974	1	1	1.00
XF1	FUSE HOLDER	30 A 250 V	20801	1		.50

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

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2 - Unit Price shown above is subject to change without prior notice.
3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
4 - Spare Quantity shown above is recommended quantity for one year isolated service.

N J E Corp. KENILWORTH, N.J.

Spare Parts List

MODEL

PAGE NO.

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*	NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
	111PC 3		81794			
C1 1	CAP FXD ELECT	900UF 80 V	13	2	1	3.00
C1 2	SA C1 1					
C2	CAP FXD ELECT	100UF 50 V	514	2	1	1.90
C3	SA C2					
C4	CAP FXD TANTALUM	2R2UF 50 V	20099	1	1	4.00
C5	CAP FXD ELECT	50UF 25 V	466	1	1	1.90
C6	CAP FXD CERAMIC	5000PF 1KV	21787	3	1	.30
C7	SA C6					
C8	CAP FXD CERAMIC	R1UF 75 V	3	2	1	1.00
C9	SA C8					
C10	CAP FXD CERAMIC	R05UF 75 V	20758	1	1	.50
C11	SA C6					
C12	CAP FXD ELECT	3X350UF 50 V	20771	1	1	4.10
C13	CAP FXD TANTALUM	2R5UF 100 V	21991	1	1	5.80
C14	CAP FXD CERAMIC	R1UF 500 V	167	2	1	1.25
C15	SA C14					
C16	CAP FXD TANTALUM	25UF 50 V	21	1	1	7.50
CR1	DIODE RECTIFIER S	2 A 200 V	103232	2	2	3.00
CR2	SA CR1					
CR3	DIODE RECTIFIER S	750MA 300 V	136	6	2	1.20
CR4	SA CR3					
CR5	SA CR3					
CR6	SA CR3					
CR7	DIODE BKDOWN 10PC	150MW 5R6 V	135	3	1	5.00
CR8	SA CR7					
CR9	SA CR3					
CR10	SA CR7					
CR11	SA CR3					
CR12	SA CR3					
CR13	SA CR3					
CR14	DIODE RECTIFIER S	150MA 100 V	129	1	1	1.45
Q1	TRANSISTOR PNP SI	225MW 30 V	4512	1	1	6.75
Q2	TRANSISTOR PNP SI	225MW 30 V	20692	4	1	4.00
Q3	SA Q2					
Q4	TRANSISTOR NPN GE	150MW 18 V	142	3	1	2.40
Q5	SA Q4					
Q6	SA Q4					
Q7	TRANSISTOR PNP SI	200MW 25 V	139	1	1	2.40
Q8	TRANSISTOR PNP SI	12 W 65 V	5002	1	1	6.80
Q9	TRANSISTOR PNP GE	500MW 40 V	390	1		6.00
Q10	SA Q2					
Q11	SA Q2					
Q12	TRANSISTOR NPN SI	200MW 18 V	21711	2	1	5.00
Q13	SA Q12					
R1	RES FXD WW	200R00 10 W	21786	1	1	1.50

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N J E Corp. KENILWORTH, N.J.

Spare Parts List

MODEL

PAGE NO. 2

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*	NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
R2	RES FXD COMP 5PCT	15R00 KR500 W	530	1	1	.20
R3	RES FXD WW	600R00 10 W	5224	1	1	1.75
R4 1	RES FXD WW	2R00 K 10 W	1751	2	1	1.50
R4 2	SA R4 1					
R5	RES FXD WW	600R00 10 W	104	1	1	1.75
R6	RES FXD COMP 5 PC	150R00 KR500 W	1031	1	1	.20
R7	RES FXD WW	R50 5 W	100	4	1	1.20
R8	SA R7					
R9	SA R7					
R10	RES FXD WW	1R30 10 W	5000	1	1	1.20
R11	RES VAR WW	500R00 2 W	107441	1	1	1.75
R12	RES FXD WW	330R00 3 W	1536	1	1	.85
R13	RES FXD WW	1R00 K 3 W	1649	1	1	.86
R14	RES FXD WW	550R00 3 W	94	1	1	.86
R15	RES VAR WW	1R00 K 2 W	107442	2	1	1.75
R16	RES FXD FILM 1PCT	50R00 KR500 W	5001	1	1	.70
R17	RES FXD COMP 5PCT	4R70K R500 W	186	2	1	.20
R18	RES FXD COMP 5PCT	15R00 KR500 W	530	1	1	.20
R19	RES FXD COMP 5PCT	1R00K R500 W	431	3	1	.20
R20	RES FXD COMP	330R00 R500 W	180	1	1	.10
R21	SA R17					
R22	RES FXD WW	1R200K 3W	5125	1	1	.85
R23	SA R15					
R24	RES FXD COMP	10R00 KR500 W	66	2	1	.10
R25	RES FXD COMP 5PCT	2R70K R500 W	185	4	1	.20
R26	SA R25					
R27	RES FXD COMP	22R00 KR500 W	69	1	1	.10
R28	RES FXD COMP	150R00 R500 W	55	1	1	.10
R29	RES FXD COMP	1R50 KR500 W	1020	1	1	.10
R30	SA R19					
R31	RES FXD COMP 5PCT	470R00 R500 W	184	1	1	.20
R32	RES FXD COMP	15R00 KR500 W	67	1	1	.10
R33	SA R25					
R34	SA R25					
R35	SA R24					
R36	RES FXD WW	820R00 3 W	95	1	1	.85
R37	RES VAR WW	200R00 R250 W	1819	1	1	5.00
R38	RES FXD WW 3PCT	760R00 3	5130	1	1	1.00
R39	RES FXD WW	200R00 3 W	1630	1	1	.86
R40	RES FXD COMP 5PCT	270R00 R500 W	193	1	1	.20
R41	RES FXD COMP	2R20 KR250 W	346	1	1	.10
R42	SA R19					
R43	RES FXD COMP	270R00 R500 W	55	1	1	.10
R44	RES FXD COMP 5PCT	3R00MR 500W	5179	1	1	.20
R45	SA R7					
XQ1	SOCKET TRANSISTOR	4PIN	128	12		.70

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N J E Corp. KENILWORTH, N.J. — Spare Parts List

MODEL

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*		NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
XQ2	SA XQ1						
XQ3	SA XQ1						
XQ4	SA XQ1						
XQ5	SA XQ1						
XQ6	SA XQ1						
XQ7	SA XQ1						
XQ9	SA XQ1						
XQ10	SA XQ1						
XQ11	SA XQ1						
XQ12	SA XQ1						
XQ13	SA XQ1						

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N J E Corp. KENILWORTH, N.J.

Spare Parts List

MODEL

PAGE NO.

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*	NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
	HS ASSY		81650			
Q1	TRANSISTOR PNP SE	170 W 70 V	109163	2	2	12.00
Q2	SA Q1					

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N J E Corp. KENILWORTH, N.J.

Spare Parts List

MODEL

PAGE NO.

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*	NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
	HS ASSY		81737			
Q1	TRANSISTOR PNP Si	170 W 70 V	109163	2	2	12.00
Q2	SA Q1					

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★**FACTORY TRAINED LOCAL SERVICE CENTERS**

Our Warranty:

NJE Corporation warrants all power supplies manufactured by it, to be free from defects in material or workmanship. Our liability, under this warranty, is limited to servicing, or adjusting any instrument returned to the factory or to an NJE field service center for that purpose, and to replacing any defective parts thereof. This warranty is made to the original purchaser and applies to all standard catalogue listed equipment for two years after delivery to the original purchaser. The provisions of this warranty shall not apply to any power supply which has been subject to misuse or which has been repaired or altered by the purchaser in any way so as, in the judgment of NJE Corporation, to adversely affect its performance or reliability, nor to normal deterioration of appearance due to wear or exposure.

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